

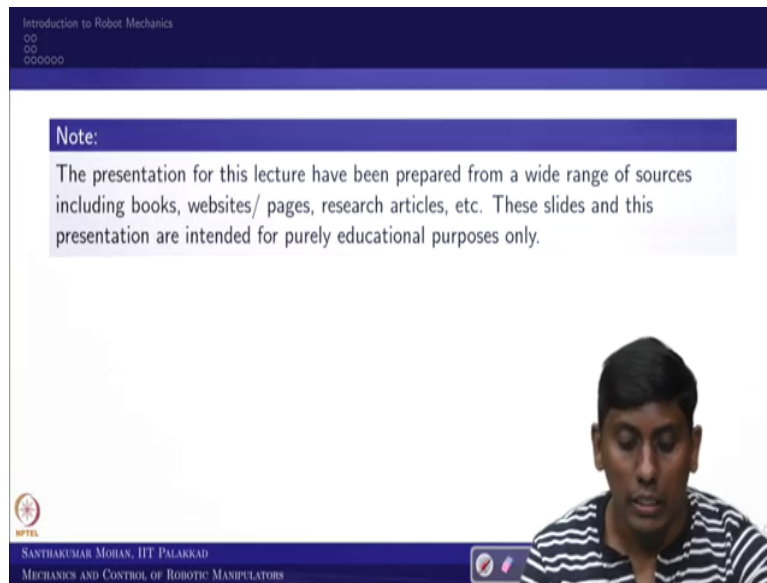
Mechanics and Control of Robotic Manipulators
Professor Santhakumar Mohan
Department of Mechanical Engineering
Indian Institute of Technology Palakkad
Lecture 01
Introduction

(Refer Slide Time: 00:17)



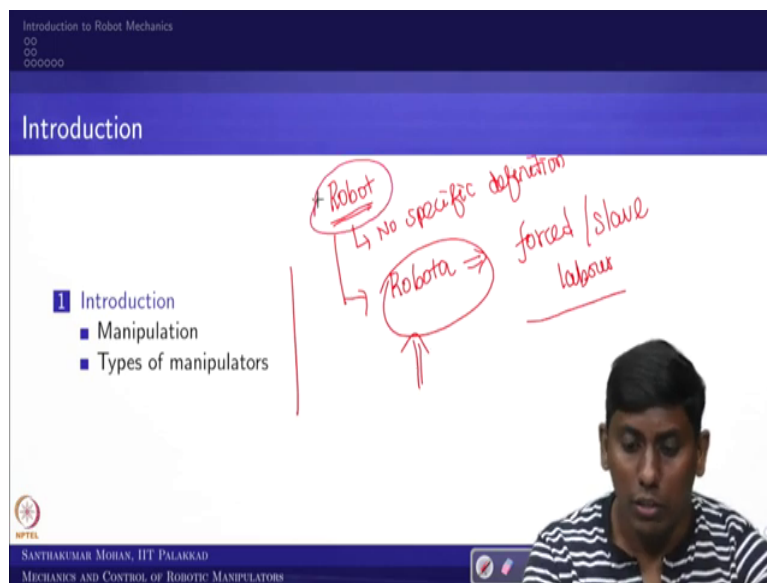
Hi! Welcome to Mechanics and Control of Robotic Manipulators. You already know that this is the 8-week course. So, this is the first lecture where we are going to introduce few of the important terms. So, before going to see these important terms, let us start very formal introduction starting from the definition of Robot. So, this is what the overall as you know most of the lectures, we would be covering with the several, you can see internet resources and the other textbooks.

(Refer Slide Time: 00:46)



So, I am just giving this particular note here. So, this lecture or this course contains few reference material from outside, so I am not referring then and there, that is what the condition here.

(Refer Slide Time: 01:00)



So, let us move to formal course called Mechanics and Control of Robotic Manipulators. So, the course name itself is same that we are going to talk about Robotic manipulator. So, let us talk about what is manipulation and what is manipulator and what are the types of manipulators? This is what the intension of this particular section of the course or the lecture of the course.

So, before that as I already mentioned we would start introducing the keyword called Robot. So, we will start giving a definition on Robot, what is Robot? So, there is no you can say specific, you call specific definition, so there is no specific definition on Robot, or you call there is no clear aspect on Robot definition. Although, this Robot keyword comes from Robota, so which is Czech keyword, which means that it is forced, or you can say slave labor.

So, this is what the whole basic idea. So, after that you know it is a completely evolved and it came with the very-very different aspect. So, we got several you call Asimov rules, although Asimov gave three rules but later it came with several other rules. So, in the sense we will first talk about what is Robot first of all?

(Refer Slide Time: 02:25)

Introduction to Robot Mechanics

Robot definition: Random House Dictionary

A machine that resembles a human being and does mechanical routine tasks on command.

RIA

NPTEL

SANTHAKUMAR MOHAN, IIT PALAKKAD

MECHANICS AND CONTROL OF ROBOTIC MANIPULATORS

Introduction to Robot Mechanics

Robot definition: Random House Dictionary

A machine that resembles a human being and does mechanical routine tasks on command.

Robotics Association of America / Robotic Industries Association (RIA)

An industrial robot is a re-programmable, multifunctional manipulator designed to move materials, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks.

re-programmable

CNC

variable programmed motions

NPTEL

SANTHAKUMAR MOHAN, IIT PALAKKAD

MECHANICS AND CONTROL OF ROBOTIC MANIPULATORS

So, we will start with the formal definition on Robot. So, I already said there in no specific definition but, we will see what the things are available. So, we have taken one of the, you can say a general Random House dictionary. This dictionary says that a machine, Robot is nothing but a machine that resembles a human being and does mechanical routine task on command. So, based on this definition what we expect?

We expect some humanoid kind of thing, right? But this is not we are expecting in this course. So, then what would be the proper definition? So, then we are going and seeing what are the associations which generated all those things. So, in that one of the bigger association which is started from America but this is what we called Robotic Industry Association.

So, this industry association RIA what it says? So, an industrial Robot, you see specifically see, it is an industrial Robot, is a reprogrammable, multifunctional manipulator. So if you talk about industrial Robot in the olden days or as per the RIA it is multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for certain case.

What for? the performance of variety of task. So, if you look at it, there are several keywords are coming, one of the main keywords which what we called reprogrammed. So, this reprogrammed is slightly different from what we conventionally use one another machine. So, what another machine we call CNC machine, the CNC machine and the Robot is different, mainly called reprogrammed.

So, then some people can call, Sir CNC also can be reprogrammed, but once the function is fixed and the entity is fixed, you cannot easily make it reprogrammable. So, that is the basic idea, but again you can see the Robot come from the CNC machine in the initial phase.

So, in that sense what one of another keywords called manipulator. So, we should know what is manipulator? So, all these need to be understood. Further you can see as per the RIA it is a multifunctional tool or multifunctional manipulator. It is not single function. So, based on this if you keep digging or keep you can say going through a several literature and the several resources or the textbooks you can see the history say several things.

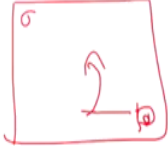

(Refer Slide Time: 04:57)

Introduction to Robot Mechanics

oo
oo
oooooo

Robot

- The term robot or robots are used more commonly used for a robotic system which has a mobility.
- Further in modern community is using this word as "an intelligent agent, physical or virtual, capable of doing a task autonomously or with guidance", example, chatbot.
- Robot is an electromechanical machine or mechatronic system with sensors, electronics and guided by computers/controllers.

NPTEL
SANTHAKUMAR MOHAN, IIT PALAKKAD
MECHANICS AND CONTROL OF ROBOTIC MANIPULATORS

What several things say that? The Robot, the term Robot or Robots are now more commonly used for certain things which is a Robotic system which has a mobility. So then, we have to see what mobility is and what is maneuverability; that difference definitely we need to talk. Further in the modern days especially in the advanced intelligent community.

What are they saying? So, the Robot means it is nothing but an intelligent agent, you see agent or device, physical or virtual, capable of doing a task autonomously or with a guidance. So, very simple example you see at Chatbot, for example, if you open a several bank sites, you would have seen this is the site page either one of the corners you can see that, so may I help you.

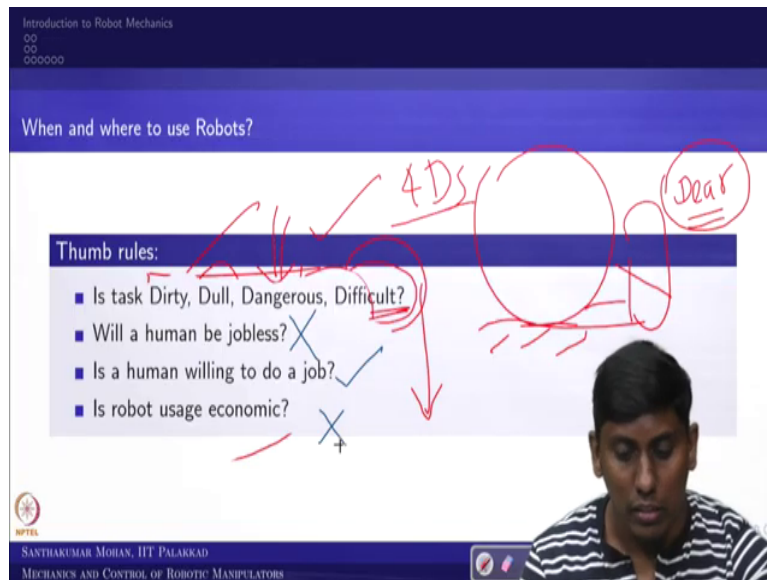
So, you click that, he says that "What can I do for you?" Then you say, some command so then it will go another that it would be keep making some preprogrammed motion, even some of the Chat bots are much more intelligent, you type based on your question it starts answering. So, these are all what in the modern-day community says Bot or Robot.

So, this is one of the best examples the chatbot, but in this course we are not talking that way. What are we going to see here? So, Robot is nothing but an electromechanical device so or machine simply we can call mechatronics system. So, with sensors, electronics or actuators and guided by computer or controller. This is what we are going to called Robot in our perspective.

So now, you can see this Robot is more common in the modern community. Even you would have seen that there are several Robotic competitions keep coming, Robotics courses are

coming even the national mission also launched the several things on Robotics and autonomous system. So, then we can have a question, so when they started what the prerequisite is or when they use or where they use the Robot.

(Refer Slide Time: 07:07)



So, for that we are answering in one simple slide here, so when and where to use Robots? So, there are several thumb rules, so we are using four of the thumb rules which would be fit into our community, at least Indian community. But, if you look at in a modern or you can say western community, so the first three Ds is what was important are: Dull, Dirty, Dangerous was the initial keyword brought for the Robotics, later on they have brought the difficult also in the case.

What that mean? If you are in environment is Dirty, where the human cannot tolerate that or it is hazardous or toxic. Then, we can employ a machine that can be preprogrammed or reprogrammable machine. In the sense Robot can be employed. Or the task is very Dull is the sense very much routine and it is giving a fatigue or the dullness to the employee or the worker then also we can use.

The third thing is definitely you will all agree, so if the task is dangerous definitely, we would be taking out the human. For example, you think about the nuclear installations or open caste mining. So, these kinds of places, definitely the human is in danger. So those kinds of places we can use.

Further what people thought about it? The task can be simple for example, a bigger object can be pushed up by a human being, this is properly easy for someone who is heavy muscular, but routine people maybe it is possible, but it is enormous work need to be done. In the sense it is difficult all the time.

For example, carrying a 50 kilograms sack may be one can do it probably one or two occasion, but in a day probably 50 times he has to carry and lift it, it is probably difficult, then we can employ. So, these are the four Ds which are initially as come, but in the modern days the four Ds becomes the difficult and dangerous they combine.

So, they brought a keyword called Dear, so although that we are going to address in the last key point but, this is another modern four D. What? Dull, Dirty, Dangerous where the dangerous brought difficult also inside, but they brought another keyword called Dear. So, whenever you see keyword Dear you assume that Dear means it is close to us.

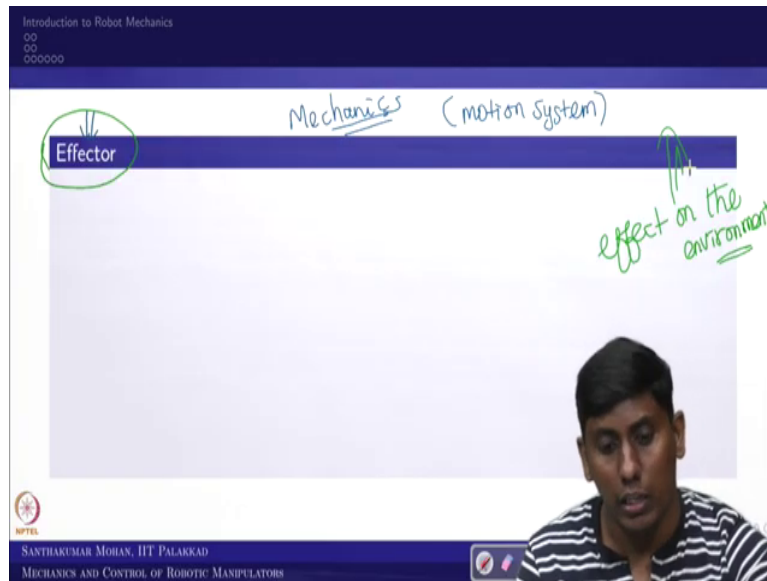
Yes, in certain extent but this Dear is slightly different. So, is the Robot usage economic then you call it is Dear. So, in that sense the modern four Ds economic benefit also. But as per the Indian community we have to see two other points, so humans being jobless? So, if that is the case, then do not employ the Robot.

So, that is what the case. So, what that means? Will the human being be getting jobless then you should not employ the Robot? Similarly, the human is willing to do even a difficult task then you have to allow the human being to do but not the Robot. So, in the sense you know when and where to use Robots right? In the modern community, in the sense current generation, the Robots no longer stick with industrial Robot.

Although, the RIA definition says that it is an industrial Robot, but in the modern days the Robot is no longer stick with the industrial soft load, it came out in domestic, medical, or outdoor. So, in the sense the classification of this four Ds or probably restriction on these thumb rules may not no longer exist.

But we can use the existing things for at least to understand this course. Because, we are focusing on the industrial base, so you can see this.

(Refer Slide Time: 10:39)



So, let us move, what would be our perspective as per what you call the mechanics perspective? So, when you talk about mechanics what we are seeing, it is a motion system, when you are talking about the motion system, we have to define Robot in different way. What way we are going to define? So, the Robot or Robotic device we are going to call as an effector.

So, what that mean? So, any device or Robotic device that has an effect on the environment, we call effector. So you have effect on the environment, so this is what the case. So, if you have anything which is having effect on the environment that we call effector. So now, based on the effect on the environment the effector can be further classified that is what we are going to see?

(Refer Slide Time: 11:30)

Introduction to Robot Mechanics
oo
oo
oooooo

Effector

An effector is any robot or robotic device that has an effect on the environment.

+ mobility manipulability

NPTEL
SANTHAKUMAR MOHAN, IIT PALAKKAD
MECHANICS AND CONTROL OF ROBOTIC MANIPULATORS

The slide features a dark blue header with the course title and progress indicators. Below the title, the word 'Effector' is written in white on a dark blue background. The main text defines an effector as a robot or robotic device that has an effect on the environment, with the key terms underlined in green. Handwritten in green ink at the top right are the words '+ mobility' and 'manipulability'. A small video inset of the presenter is visible in the bottom right corner.

That is very much important for us, for example this is a definition which I mentioned that has an effect on the environment. So now, what I said, the effect on the environment can create two kinds of the actions, so one is mobile or you call mobility, so the other one is, so can create manipulability. So, one can create a mobility, the other one can create manipulability.

(Refer Slide Time: 12:02)

Introduction to Robot Mechanics
oo
oo
oooooo

Effector

An effector is any robot or robotic device that has an effect on the environment.

human locomotion
manipulation
ball

NPTEL
SANTHAKUMAR MOHAN, IIT PALAKKAD
MECHANICS AND CONTROL OF ROBOTIC MANIPULATORS

The slide features a dark blue header with the course title and progress indicators. Below the title, the word 'Effector' is written in white on a dark blue background. The main text defines an effector as a robot or robotic device that has an effect on the environment, with the key terms underlined in green. A diagram in the center shows a soccer player kicking a ball, with a green circle around the ball and a green arrow pointing to it labeled 'ball'. Another green arrow points from the player to the text 'human locomotion'. A third green arrow points from the ball to the text 'manipulation'. Handwritten in green ink are the words 'human locomotion', 'manipulation', and 'ball'. A small video inset of the presenter is visible in the bottom right corner.

Introduction to Robot Mechanics

oo
oo
oooooo

Effector

An effector is any robot or robotic device that has an effect on the environment.

- **Locomotion:** if the effect on the environment causes motion of the effector itself.
Mobile robot
- ✦ **Manipulation:** if the effect on the environment causes motion of the objects around.
Robotic manipulator

NTPL

SANTHAKUMAR MOHAN, IIT PALAKKAD
MECHANICS AND CONTROL OF ROBOTIC MANIPULATORS

For understanding that, I took a simple picture where you can see human, and you can say ball are taken. So, the ball and human are taken, so one picture you can see there is a human standing on the ball, so now when he roll his leg, what he can get? So, this ball will start role, but you can see that the effect over you are creating, the effect on the environment creating on this ball.

But, because of that what you are going to get this human would be getting mobility. So, this particular action what we call is locomotion. So, we are trying to get a locomotion because of the action on the you call the effector. The effector is creating effect on the environment, creating a mobility of effector itself.

Whereas the other way around the human is lying down and he is doing the same thing, he is manipulating his legs, or you can say, he is moving his legs, because of his movement of the leg what happened? This ball will roll, or it can go away. In the sense what he is trying to do? He is trying to manipulate this ball. So in the sense what we are trying to do, so we are trying to do the manipulation.

So, what that way? The effect on the environment causes motions of objects around but here the motion of the effector itself. The effector itself you called locomotion, so motions, objects around called manipulation. So, these are the two classifications which we are doing it, one is if the effect on the environment causes motion of the effector itself, we call it locomotion.

The locomotive device what we called in Robots; it is mobile Robot. The other one is if the effect on the environment causes motion of the objects around, which is what you call

manipulation, the manipulating device what we call manipulator. Since, we are talking about robotic device, so we are going to classify that as robotic manipulator. So, now I hope you are clear so what is manipulator and what is mobile Robot? And you are clear that what is locomotion and what is manipulation?

(Refer Slide Time: 14:07)

Introduction to Robot Mechanics
00
00
000000

The role of the controller is to get the effectors to produce the desired effect on the environment, based on the robot's task.

NPTEL
SANTHAKUMAR MOHAN, IIT PALAKKAD
MECHANICS AND CONTROL OF ROBOTIC MANIPULATORS

Introduction to Robot Mechanics
00
00
000000

The role of the controller is to get the effectors to produce the desired effect on the environment, based on the robot's task.

NPTEL
SANTHAKUMAR MOHAN, IIT PALAKKAD
MECHANICS AND CONTROL OF ROBOTIC MANIPULATORS

Let us move what would be covered in this particular course? So, in this course what we are going to cover? We are going to cover this very specific aspect called the fixed manipulator in the sense what that mean, so the manipulation can be end up, so one end is fixed the other end is going to connect with the objects around that would be manipulating the objects whereas the other one is locomotive device which is nothing but mobile Robot.

Now, there may be one question can come. So, what would be the role of controller? So, the controller should be called as an effector. Strictly said, no. So, then what would be the role of the controller? The role of the controller supposed to be to produce or can say the desired effect on the environment based on the Robot task.

In the sense it supposed to make sure that the effector will get the necessary desired effect. For example, if I want to move this Robot in straight line so, these four wheels which is going to generate the force on the ground or the effect on the environment; create a traction that should make in such a way that the Robot will move on the straight line.

So, now the same way this object supposed to move, maneuver so you can do it. Now, one simple question will come, so this is fixed manipulator, and this is a mobile Robot, can I take this and put it on top of this? Yes, you can do, so that is what we call mobile manipulator, which will give dual advantage of you can say manipulator and mobile Robot but, it will give additional limitations also that we will see at the end of this course.

So, what we call you can say mechanics of mobile manipulator. But right now, what you can understand? If I put this on top that is what you call mobile manipulator or simply vehicle manipulator system. So now, let us see what would be the benefit when we start understanding this, what you call mobile manipulator or manipulator?

So, the manipulator is simple because it is fixed, so then you can see the environment would be or the workspace would be confined. So, you can always have a confined workspace and then because of the confined workspace even preprogrammed motion can be generated. But, in this case it is not so easy. So, that is one important thing, we will see the difference in detail.

(Refer Slide Time: 16:29)

Introduction to Robot Mechanics
00
00
000000

Our perspective

A robotic manipulator is a software controlled mechanical device that uses sensors to guide one or more of end effectors through programmed motions in a given workspace in order to manipulate physical objects.

NPTEL
SANTHAKUMAR MOHAN, IIT PALAKKAD
MECHANICS AND CONTROL OF ROBOTIC MANIPULATORS

The slide features a green header with the title 'Our perspective'. Below it, a text box defines a robotic manipulator. A hand-drawn green diagram illustrates a robotic arm with a gripper. The NPTEL logo and the presenter's name and affiliation are visible at the bottom.

So, let us move further, so what would be our perspective of this course? So, we would be talking about robotic manipulator, that is nothing, but a software controlled mechanical device that uses sensors to guide one or more of end effectors to through programmed motion in given workspace to manipulate physical objects.

In that sense the mechanical manipulator would not come as Robotic system. For example, I have mechanical motion, so this mechanical motion would not be come under. It supposed to be electrically connected with some kind of controlled device, so then only you can call as Robotic system.

(Refer Slide Time: 17:10)

Introduction to Robot Mechanics
00
00
000000

Manipulation:

If the effect on the environment causes motion of the objects around.

- Robotic manipulator

robot

NPTEL
SANTHAKUMAR MOHAN, IIT PALAKKAD
MECHANICS AND CONTROL OF ROBOTIC MANIPULATORS

The slide has a blue header with the title 'Manipulation:'. Below it, a text box defines manipulation. A bulleted list includes 'Robotic manipulator'. Three images of different robotic manipulators are shown. The word 'robot' is written in red and circled. The NPTEL logo and the presenter's name and affiliation are visible at the bottom.

So that is what we are trying, so now we can see we will bring back what is manipulation? So, what is manipulation? If they effect on the environment, causes motion of the objects around so now, you can see, so this is not a new thing? The Robotic manipulators is not new thing, it started in 1960, it matured in 1980 and 1990s and started ruling the world, so then what the generation change?

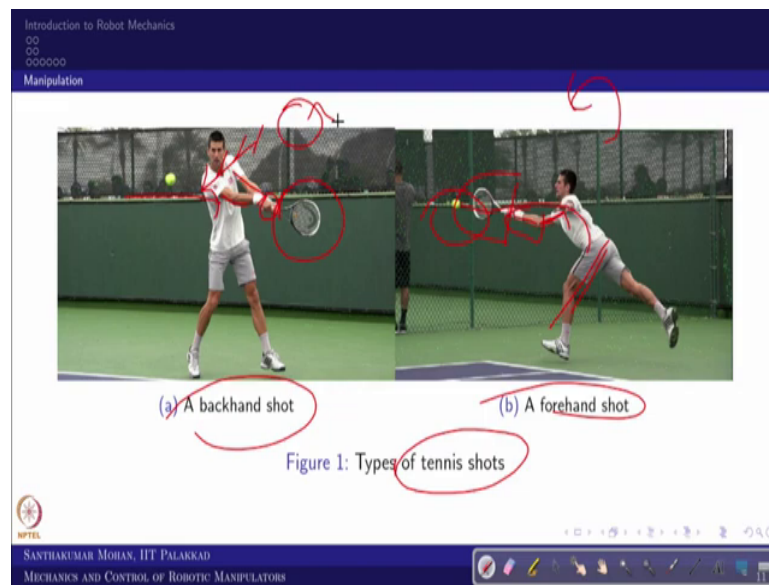
So now, the generation changed from this where this is the conventional Robotic manipulators which would be having gravity balanced with parallelogram mechanism, counterweight and all. And all the actuators at the bottom and the controller, controlling station all in the bottom, you can see, even the small 1 kg payload; it would be having a very heavy structure.

Then people thought about can we use cable operator? So, then they called compliant Robot where everything would be connected with the cable which is easy for us to control and as well as maintain the stability, in the sense gravity balance. So, this is the second generation from the conventional rigid bodies which is very massive bodies to some kind of a compromised one.

But what additionally done in the current perspective we call, we are in the arena or area of we call co-bots. What that means? You can see the actuators are simple disk type, in addition to that these Robots are gravity balance done with a simple you can say spring system or cam and a cable operator. Further what advantage? These all the system would be having a sensor, when you hit this, so this will stop and react later.

So, in the sense this can be easily applied for the human interacted environment, we call co-bot scenario. So right now, we are in the collaborative environment we called co-bot. So, this is what we are in the current perspective. We are going to study about all this because we are going to study about the mechanics so we can see how this is different from this, all those things we can study, why it is a better that also we can see.

(Refer Slide Time: 19:22)



So, let us move further, so we know now what is manipulator? Now we need to define manipulator, already we did. So, additionally, how we can classify this into number of things. So, one of the easiest ways we can classify, for classification I took this particular images, I have taken two of tennis shots, one is backhand, the other one is forehand.

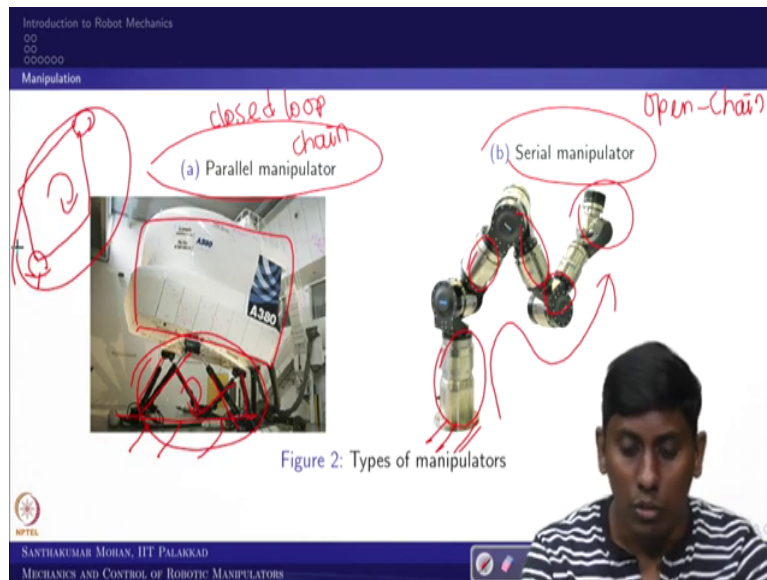
So, what one can see, the person who is the same person, so he is you can see the serve, he is taking it at this end effector which is nothing but the tennis racket, so it is supposed to take this ball, so for that he needs more power, for that time what he is doing? This end effector is the base because he is grounded, so this is connected with two serial chains connected in parallel way.

So now, what it is giving? It is giving a closed loop, whereas when he wants to take a side court shot, the end effector is still the racket but what is doing is connected in series, in the sense this is grounded, but he is reaching through series connection. So, these are the two differences, so one is an open so the other one is close.

So, the close which is what we called parallel manipulator, even you can take our own example, so for example, now you want to take a 5 kilo you can say or 5 litter cooker from the stove, so you will not take one handed, it is very heavy right, you would use two hands why because you can manipulate or you can hold in better way.

So, similarly you can see when you put your head you can say sad occasions, we will keep your head this, right. When you put it so that time you make a close loop. So, these are the cases.

(Refer Slide Time: 21:18)



So, now based on that background you can see one additional aspect, we will bring two such cases one is serial manipulator the other one is parallel manipulator. What is serial manipulator? So, the bodies are arranged in series, it makes open chain, where the end effector to the base is in an open chain. So, that is what we call, so it is open chain manipulator.

This is parallel chains, for example, this airbus cabin supposed to provide or supposed to get required motion that is controlled in three you can say legs here and additional three legs, so totally you can see six legs are providing the motion. But what you can see? This is grounded and this is mobile platform that is connected with several serial legs which makes several close loops.

What that mean this is giving a closed loop chain, so which is what you call parallel connection. In the sense, so for example, you take your serial chain, and you connect it with another serial chain, what happens? This would be making a close loop, that will give high payload but it would be restricted to the smaller workspace.

(Refer Slide Time: 22:36)

Introduction to Robot Mechanics
Types of manipulators

Types of manipulators

- 1 Serial (open-chain) manipulators ✓
- 2 Parallel (closed-chain) manipulators ✓
- 3 Hybrid (combined) manipulators

SANTHAKUMAR MOHAN, IIT PALAKKAD
MECHANICS AND CONTROL OF ROBOTIC MANIPULATORS

So, that is what we are going to see as few types, so one is open chain so the other one is closed loop. So, open chain manipulator we call serial, the closed loop we call parallel. It can be combined, for example, you can see the parallel connected with the serial, so, the extra parts toward platform connected with the SCARA Robot, we will see what exactly that in detail.

So, this will give a hybrid combination, in the sense combined manipulator. This is we will see it is giving a close loop, but this is giving an open loop chain. So, this is what the background and the classification.

(Refer Slide Time: 23:07)

Introduction to Robot Mechanics
Types of manipulators

Serial vs. Parallel manipulators

- x large workspace
- x stiff
- x fast
- x precise

SANTHAKUMAR MOHAN, IIT PALAKKAD
MECHANICS AND CONTROL OF ROBOTIC MANIPULATORS

So, further I want to give, the open chain will give a larger workspace that you would have already seen. The tennis player opens his hand because he will get larger work space, whereas when he want to take high load he would close.

What that mean? Your body would be making a stiffer your connection, the end effector would be rigid for and acts faster and makes a precise movement. So, that is what the case, you can see, both are industrial Robots, but this is having a several, you can say closed loop, but this is open. This is the basic difference.

(Refer Slide Time: 23:42)

The slide is titled "Serial vs. Parallel" and is part of an "Introduction to Robot Mechanics" presentation. It defines two types of manipulators:

- Serial robot:** A fixed base, links and joints connected sequentially and ending in an end-effector.
- Parallel robot:** More than one loop (end-effector connected with multiple serial chains), no natural end-effector.

The slide features a diagram of a parallel robot with six actuators and a small video inset of the presenter, Santosh Kumar Mohan, from IIT Palakkad. The slide footer includes the NPTEL logo and the course title "MECHANICS AND CONTROL OF ROBOTIC MANIPULATORS".

But, when we see the other way around the serial Robot we know though, one of thing is fixed based but the links and joints connected sequentially and the ending in an end effector. Whereas the parallel Robot more than one loop end effector connected with multiple serial chain. You can see, right. So, there are six actuators, but this is connected in parallel way. But this is open which is the serial chain.

(Refer Slide Time: 24:09)

Introduction to Robot Mechanics
oo
oo
oooooo

Types of manipulators

According to rigidity

- Rigid link manipulators
- Flexible link manipulators

NPTEL
SANTHAKUMAR MOHAN, IIT PALAKKAD
MECHANICS AND CONTROL OF ROBOTIC MANIPULATORS

The slide shows a presentation slide with a blue header and footer. The main content is white with a blue bar for the title 'According to rigidity'. Below the title is a list of two items: 'Rigid link manipulators' and 'Flexible link manipulators'. To the left of the list is a photograph of a white industrial robot arm. A red circle is drawn around the word 'rigidity' in the title and around the robot arm image. In the bottom right corner, there is a small video inset of a man in a striped shirt.

Introduction to Robot Mechanics
oo
oo
oooooo

Types of manipulators

According to rigidity

- Rigid link manipulators
- Flexible link manipulators

NPTEL
SANTHAKUMAR MOHAN, IIT PALAKKAD
MECHANICS AND CONTROL OF ROBOTIC MANIPULATORS

The slide is identical to the first one, but instead of a single image of a rigid robot arm, it features two images side-by-side. The left image is the same white industrial robot arm. The right image shows a blue and white snake-like robot with a red line tracing its path. A red circle is drawn around the word 'rigidity' in the title and around the snake-like robot image. The video inset of the man in the striped shirt is also present in the bottom right corner.

So now, we will add additional information? So, the manipulator further can be classified based on the rigidity or based on the construction. It can be rigid link where this is at any given point, so distance between two points would not change. So, in that case what you call, the link would be rigid, so the rigid link manipulator is one classification.

So, the other case the link can be flexible. So, for example, time to time it is getting change. For example, snake or flexible member, for example, pneumatic muscle and all. So, in that case this is called a flexible link manipulator. So now you got some kind of idea, so only one thing I want to add here, is that the serial Robot would be having one Degrees of freedom.

So, all the joints which is having one degree of freedom, so we would be seeing what degrees freedom in the next lecture? but this will have open and one member which should be connected with another member is only one motion provision where parallel Robot would be having more flexibility. So that is what the case.

So, with that said, in this lecture so what we have seen, so what is manipulator and what are the types. So, in the next lecture we would be seeing the Robot mechanics in specific manipulator mechanics, we will start with the degree of freedom, and we will end with one of the basic entities in Robotic manipulator called Robot kinematics. So, until then see you, bye, take care, see you then!